THE EVOLUTION OF MIND.

BY E. D. COPE.

(*Continued from page 913.*)

IN the provision and care for the young animals display a great fertility of resource, beginning low in the scale. It is well known that certain Siluridæ (catfishes), Gasterosteidæ (sticklebacks), and Percidæ (sunfishes) of North America make nests for the reception of the eggs, and that they take care of the young. It is not an uncommon sight, in suitable places in our country, to see the catfish, *Amiurus nebulosus*, lead about its shoal of young fry like a hen with her chickens. Other Siluridæ of South America take the eggs in the mouth, and so protect them. In these and similar cases we may imagine that the animal regards the eggs and young as part of itself, to which it attaches a certain value, as in ordinary self-preservation.

Such an explanation serves in the case of the ants and bees, which show such care of their young. Some of the most remarkable cases of this kind are to be found in the Batrachia Salientia, an order not distinguished for intelligence in any other direction. In some parts of South America and Africa, where there is a dry season, certain tree-frogs deposit their eggs in masses on the branchlets and leaves of trees that overhang the dry beds of streams. The surface of the gelatinous albumen, in which the eggs are enclosed, hardens by evaporation, so that the latter are well protected. On the arrival of the rainy season, the stream below the nest begins to flow, and the nest is dissolved and washed into it, so that the larvæ can pass their branchiferous larval stage successfully. It is interesting to note that the species which adopt this habit are not closely allied in a systematic sense, the African belonging to the Ranidæ, and the South American to the Hylidæ. They have learned the habit independently of each other. Another tree-frog, of unknown species, inhabiting Japan, has been shown by the Rev. W. S. Holland to construct a

similar nest, but of a larger and less solid character. The interior remains semi-fluid, and the eggs hatch and the young pass there a part at least of their larval life before dropping into the stream below. The region is not subject to drought, so that the object of this habit may be to escape enemies which may lurk in the water.

In South America certain Hylidæ (Notrotrema, Opisthodelphys) and Pipidæ (Pipa) adopt the habit of placing the eggs on the back. The former mostly inhabit a region which suffers from drought,—the western slope of the Andes. They retain the eggs in an invagination of the dorsal integument until they are hatched, and in some cases until they have passed their metamorphosis.

In the genus Dendrobates (Dendrobatidæ), also South American, the tadpoles are carried over land on the back of the parent, attached by their mouths, to a new pond, when the old one dries up. The most peculiar modification is that adopted by the *Rhinoderma darwinii* of Chili (fam. Phryniscidæ). The male takes the eggs into his vocal sac, which is entered from the floor of the mouth. This sac is greatly extended in this species, reaching below the entire abdomen. Here the eggs hatch, and the tadpoles remain till such time as they complete their metamorphosis. As in the stickleback and the catfish, this is a case of paternal instinct.

The intelligent efforts of certain birds to divert the attention of enemies from their nests are well known. Two prominent cases of this kind in North America are the woodcock (*Philohela minor*), and the oven bird (*Siurus aurocapillus*). The flutterings of these birds along the ground, apparently in easy reach of the grasp of the pursuer, lead the latter far from the nest. When safety is assured, the bird flies away unharmed. The two species mentioned have no zoological affinity with each other, so that they have adopted the habit independently.

In the capture of prey animals often show a remarkable knowledge of the physical characters of the latter. Thus the ophiophagous snakes seize venomous species by the muzzle, thus keeping their mouths closed and preventing their biting. The wonderful habits of the species of mud-wasps in this respect

have often been observed. They capture the species of insects and spiders which they store for the use of their young by stinging them in the nervous ganglia in such a way as to paralyze without killing them, thus preserving them alive for many months.

The construction of webs by spiders furnishes an excellent illustration of the progressive development of a capacity for mechanical construction. The inferior forms construct loose nets in the grass. Another type adds to this a funnel-shaped retreat, in which they lie in wait. A higher form suspends a triangular net between the branches of a bush, while the perfection of the art is reached by such Epeiridæ as spin a complete disc composed of many triangular segments, which often contains a staircase from the centre, arranged for their ready escape from an enemy. At some early period in the history of the spiders an intelligent perception of the utility of a web in the capture of prey must have been attained. The habit of making the web has become ingrained or instinctive, and has by use absorbed the faculties of the species. Accident has perhaps led to the habits of constructing them differently with relation to the environment, such as the surface of the ground, etc. The triangular form is the simplest possible device for a suspended web, while the discoidal web is constructed by a simple repetition of the same device. This probably means merely increased capacity for web-construction; that is, increased secretion of web-substance, and increased nervous activity, both the result of use.

The intelligence displayed by the higher animals in the capture of prey is well known. I once had a tame raccoon which was fastened by a chain of moderate length in a stable. He frequently attempted to catch the chickens that entered the stable, but was prevented by the shortness of his chain. But he adopted a device which was successful. He collected the remains of his meals within the circle of which his chain formed the radius. He then pretended to go to sleep at a point near the the centre of the circle, while he slyly watched the birds. The latter approached, and, becoming confident, proceeded to peck at the fragments. The raccoon then easily pounced upon and caught them. In the pursuit of their prey dogs, as is well known, display much

intelligence. Some of them anticipate the arrival of deer, which run in a circle, by cutting across its diameter and reaching a point in advance of them. In the same way foxes show remarkable intelligence in their endeavors to escape from dogs in pursuit. They double on their own tracks, and run in water to destroy and confuse the scent. These actions show reasoning capacity of a very respectable order.

The Hymenopterus insects display the most remarkable powers of self-preservation and protection through social organizations. This intelligence was probably reached at some early geologic age, and it has been followed by remarkable consequences, both to themselves and to other members of the animal, and not less to the vegetable, kingdom. It may be truly said that man himself has produced no such important constructive effects on other organic beings, although his destructive effects have been probably greater. In the first place, the habits of many of the order in seeking their food in flowers have probably been the active agency in determining the forms of many of the latter, as well as of developing the nectariferous glands and increasing their secretion. This view was suggested by Müller and myself at about the same time, and has been elaborated by Henslow in one of the volumes of the International Scientific Series. In the next place, a number of animal types have been called into existence through the food and protection offered by the domestic economy of the ants. Among Vertebrata we have three families which live in ants' nests, all of which have become blind or nearly so, and two have lost their limbs, through the adoption of their parasitism on ants. Such are the Cæciliidæ (Batrachia), Amphisbænidæ (Lacertilia), and Typhlopidæ (Ophidia). Then many birds (Formicariidæ) live on ants and Termites, and two families of Mammalia, the Myrmecophagidæ in South America, and the Orycteropodididæ in Africa. Thirdly, the ants have domesticated numerous species of insects which they use for their secretions and for other purposes. In Europe about one hundred such species are known. The slave-making habits of various ant species are well known. This habit has been so long existent in certain species that the latter cannot exist without the aid of

their slaves. The latter care for their young, and even procure food for the adults. This habit is an illustration of a misdirection of intelligence. Originating in an intelligent appreciation of what the slave ants could do for them, they have become so dependent on the latter as to have lost some of the most important functions of self-preservation, so that their persistence in future time is necessarily more precarious than that of any other type of ants, *cæteris paribus.*

The fact that the practice of stirpiculture and social division of labor, with the laying up of food supplies, has developed independently in three different phyla is of much interest. These habits are exhibited by the Formicidæ and Apidæ of the order Hymenoptera, and by the Termitidæ of the Neuroptera.

The habits of the beaver display intelligence in two directions. They adopt an effective measure of security in building their dams so as to flood the entrances to their houses, thus protecting themselves from many foes. Secondly, they display mechanical skill in the construction of the dams, and in the location of their houses.

Some of the monkeys are the most intelligent of the animals below man. I had in confinement for several years three species of the South American family of the Cebidæ, which stands lower in the scale than the monkeys of the Old World. One of these was an Ateles, and it was rather stupid. The others were the *Cebus capucinus* and the *C. apella.* The former was the more intelligent. I have already referred to the tendency of these species to syncope under extreme fear. The *C. capucinus* possessed unlimited curiosity. Everything that came into its possession was closely scrutinized, and would be broken up, if possible, and the interior examined. It used sticks and stones for its purposes, much as is done by man. With the former it reached for objects not otherwise attainable, and in their absence would unfasten the leather strap that passed round its waist, and whip in desirable objects by throwing the free end round them. Sticks were used in defence, and were either thrown or held in the hand by one end. Pounding the shining sconce of a bald-headed friend was an amusement for which it was always ready. It threw stones

with considerable precision, overhand. Stones were also used for cracking nuts and other objects, and when the latter were resistant, it would leap in the air and bring the stone down with great force, and with many grotesque attitudes and grimaces.

It would draw bolts, lift hooks, and pull out nails which closed the door of its cage. I never knew it to open a buckle correctly, but it would pull out the threads which fastened the fold of leather which held the buckle, and so free itself from the strap. On one occasion it imitated the use of the drawing-knife by carpenters who were at work in the room in which its cage was kept. It secured a square rod of wood, and some fragments of sheet tin which had been left near its cage. It carried the wood to a shelf in the cage and sat on it, letting it project forward from between its legs. It took a piece of tin in both hands, and placing the edge across the wood, drew it rapidly backward and forward on the latter, just as the carpenters use the drawing-knife. This action it repeated frequently, with many grimaces and expressions of delight.

It was very expert in the management of its chain. It carried it in a coil of its tail over obstructions and objects on which it was likely to be caught, quite as carefully and successfully as could have been done by a human being. In this it showed its intelligence to be superior to that of dogs, cattle, or horses, who will wind themselves up when tied, and cannot unwind or extricate themselves.

In all these exhibitions the Cebus displayed predication, or conception of the consequences of certain causes; *e.g.*, the effect of being wound up, and the effect of carrying the chain in relation to its environment.

The Cebus was evidently conscious of wrongdoing. When detected in some particularly mischievous proceeding his furtive and downcast looks showed that he understood the nature of the act, and that before any word was spoken. He perfectly understood the tones of voice of his master, showing alarm or satisfaction as the case might be. In attacking a strange animal, as a dog, cat, or chicken, he always waited for the word of command; on receiving it he would spring towards the enemy with loud

ejaculations of hostility and open mouth, looking frequently to his master for approval.

When inclined to be sociable he made rapid movements of the jaws and lips as though endeavoring to talk, an appearance which was increased by the attitudes of the head and the inquiring expression of the eyes. The same habit is to be observed in the Old World monkeys, as in Cercopitheci and baboons. It appears to be one of the preliminary endeavors which in the ancestors of man led to the function of speech.

Deliberation and Judgment.—The condition of deliberation is a restraint of intended action in view of alternatives and uncertainties. This attitude of mind requires attention. As such action involves an intention, more or less distinct, it presupposes also an inductive basis of knowledge, and a deductive application of the same in practice.

Attention is commonly observed in animals, even of the lower types. A slight stimulus, as a sound, will arouse it, and it will be often continued long after this stimulus has ceased. This is commonly observed in Mammalia and in birds. It is well exhibited by tortoises and by snakes. The snake-like lizard, *Opheosaurus ventralis*, is easily tamed, and displays careful attention to the movements of its master.

Deliberation is seen in the careful selection of a suitable place for the deposit of eggs by a great many animals. Urged on by the emotion of egg-laying the animal restrains its desire until a place is found when the precious property can be safely concealed from the eyes of enemies. This kind of deliberation is seen as far down as the fishes, and the insects probably exhibit it as well. It is also seen in the careful examination of articles which may or may not be edible. Monkeys are untiring investigators, and they often scrutinize and critically taste objects with an evident view of ascertaining their character as edible or not. Carnivora pursue the same object by the use of the sense of smell. Fowls and other birds often deliberate over a doubtful object.

A dog will deliberate as to whether another dog or another animal is hostile or dangerous or not. An amusing illustration of this faculty is seen in the close consideration which a dog will

give to an insect which more or less resembles a bee or wasp. I have seen a bull-dog examine with care a large fly which resembles a bee, and evince much doubt as to whether it might be safely snapped up or not. When urged to attack the dog would do so with lips retracted and dripping with saliva, so that the teeth only might come into contact with the suspicious insect. This amusing illustration is well represented by a Belgian painter in a picture exhibited at the Paris Exposition of 1878.

In forming a decision on deliberation an animal performs an act of judgment. Like a concept, a judgment may be very simple or it may be complex. Its grades depend exactly on the grade of the percepts or concepts which are compared. But whether simple or complex, the formation of judgment is a metaphysical act. It results from a comparison of memories of percepts, or of generalizations derived from concepts of all degrees of generality.

Self-Consciousness.—This is a grade of consciousness which is probably found only in the human species, and is probably wanting to the lowest of human races. It is the introspection which occupies itself with one's own mental states. It more frequently occupies itself with past than with present mental states, for man is not accustomed to reflect on the character of his own mental acts when in action. He is conscious of them, as he is conscious of the movements of his own body, and he may also be as unconscious of the one as he is of the other. Moreover, self-consciousness may extend to the simplest mental acts as well as to the most complex. Hence I cannot agree with Mr. Romanes, who makes self-consciousness the condition of the formation of a concept. Nor can I think he has used the word subject in the usual sense when he restricts it to the self-conscious mind. The subject is that which is conscious in any degree, as distinguished from object, which is that of which the subject is conscious. So the insect, feeling pain, is quite as much a subject as a self-conscious man. Self-consciousness is a form of consciousness possible only to the highest grade of intelligence. In its exercise the subject becomes an object, when it is well termed the "subject-object." We have no certainty that any animals pos-

sess this capacity, but it is quite possible that some low types of men rarely or never practice it. This we may derive from their vocabularies, from which words expressive of introspective mental states are absent.

Consciousness of one's body and of one's mental sensations is no doubt present in animals. This is, however, simple consciousness, and not self-consciousness. Animals also possess consciousness of the mental states of other animals and of men. This is an inference based on their appearance, gestures, tones, etc., and one more evidence that many animals possess the rational faculty of induction or inference.

4. THE METHOD OF MENTAL EVOLUTION.

That the highest type of mind, as seen in mankind, has been produced by a process of evolution by descent from primitive beginnings would seem to follow from the history of the organism which displays it, *i.e.*, the nervous system and its ganglia. Whether there is any insurmountable obstacle in the way of such a belief will be considered in the present section.

We have traced the existence of various component elements of mind among the lower animals, and have found that the only quality which is not common to them and to man is that of self-consciousness. And of this there is doubt as to its existence in the lowest human races. We have, however, recognized that the animal mind cannot reach so high a grade of conception in the classification of the mental contents, as can man. But we have seen how very greatly human minds differ in this respect, so that there may be said to be a rising scale of mental organism from the lowest animal to the highest man, with but a slight interruption at the point where we pass from the highest ape to the lowest man. This slight interruption is due to the advent of language, which gave the mind a new machine, by which its power of accumulating experience was increased, and a firm hold over its conceptual faculty acquired. The very inferior quality of the minds of the lowest races, however, leads us to infer the former existence of still less intelligent men, and their extremely simple languages lead us to suspect that the time was when man devel-

oped language from inarticulate sounds and gestures, precisely as he has since developed new complexities expressive of the progressive advance of his mental power.

Mr. Romanes, in his work on the "Origin of Human Faculty," has been at great pains to examine and elucidate the question of the origin of the human intelligence, and I cannot do better than refer my readers to it as the best exposition of the subject in existence.

The experiential theory adopted by Locke as a statement of the history of the human mind has been shown by Herbert Spencer to be more correctly an explanation of the development of the mind of animals in general, including that of man. On this hypothesis, while it is admitted that much may be acquired by each individual human mind by experience, it is asserted that more has been acquired by the race in general, and handed down to the existing generations by inheritance. It is further held that the elements of the mind of man were not acquired by him at all, but have been derived by him by inheritance from the preëxistent members of the animal kingdom from whom he is descended. It is the qualities which are thus inherited which appear to the student who is unacquainted with this explanation of their origin to be spontaneous, or "intuitive" to the human mind. Thus the so-called intuitions of man are shown to be the organized products of the experience of preceding generations. The question of the origin by experience of the powers of thought of man is quite independent of the metaphysical question as to whether a given truth is contingent or necessary. The former may depend more directly on experience than the latter, but the capacity to apprehend the latter is as necessary a result of evolution as is the capacity to apprehend the former, if the evolution of the human mind be admitted. Of the truth of this mode of explanation of the origin and growth of the latter there seems to the present writer to be no doubt.

As sensation appears to be present in some or all of the Protozoa, without corresponding organs of sense, general or special, we believe that their protoplasm or part of it is endowed with a diffused conscious sensibility. Organs of a special sense, sup-

posed to be sight, are present in many Infusoria in the form of small aggregates of red or black pigment. From such a source organs of developed sight can be traced, the subsequent additions of retinal nerve supply, humors, etc., having been observed in animals of successively higher types. Thus we have ground for believing in the evolution of this form of special sense step by step.

General sensation is immediately localized on the appearance of special organs for its activity. These are the threads and bodies, termed nerves and ganglia, which appear first in the ascending scale in the Cœlenterata. From the simple structures presented by the jelly-fishes we trace the successive evolution of the nervous system up to its highest expression in the Mammalia and in man. Thus we have the physical basis of the evolution of sense-perception plainly before us. The belief in the evolution of the more complex forms of perception from simple consciousness is therefore inevitable.

The evolution of ideation may be traced along the lines of the affections and of the intelligence. The affections differ among themselves in degree of intensity as well as in kind. In their simplest form they are mere preferences, or likes and dislikes; in a more pronounced type they are the affections; while in their forms of greatest intensity they are the passions. The evolution of the emotions is therefore quite comprehensible under the direction of use and experience. Profitable use develops strength, while experience of the evils of unprofitable use develops restraint and disuse. The desires and affections furnish the stimuli to action, whence comes experience, and therefore ratiocination. Reason, in turn, furnishes material to the affections, and also guides them to the accomplishment of their desires.

It is evident that without consciousness the development of ideation would be impossible. Ideation is a result of education or the experience of pleasures and pains. The appetites are conscious states, and they furnish, with general and special sensation, the basis of the knowledge which animals possess of the material world. Granted consciousness, and the progressive development of ideation is necessary, except in certain cases where degeneracy

is exhibited. The changes of the seasons, the periodicity of the appearance of vegetable food, the irregular production of animal food, the struggle for existence between animals themselves, all furnish the materials of memory, and the stimuli to emotion, attention, conception, induction, and all forms of mental activity. By means of memory these results are cumulative; and by reason of the effects of these activities on structure of the nervous centres the faculties themselves are augmented in power, and may become finally automatic, or be performed without the presence of consciousness. Such automatic acts or habits may become so fixed as to be surrendered with difficulty, or not at all, after changed circumstances render them no longer beneficial. They are termed instincts, and for a long time an essential difference was believed to exist between Instinct and Reason. But it is now evident that man possesses the primitive instincts in common with the lower animals, and various tribes of men display especial characteristics which have become congenital, and may be properly termed instincts. Such are the habits of a nomadic people, which they give up with great difficulty. Such is the instinct for the chase which persists in some men so that they move ever further off the frontier of a more sedentary civilization. Since it is known that many of the lower animals can reason, the supposed distinction between Instinct and Reason disappears entirely.

As in structural evolution, ontogeny furnishes us with a guide to phylogeny. The study of the growth of the infant mind throws much light on its general evolution. The primitive condition of the emotions is that of appetites. The first of these in the necessary physiological order, and hence in time, is the appetite of hunger. Second in order in the history of life, but not in the growth of individuals, is the instinct of reproduction, such as it is in animals who only multiply by fission. Very early in evolution the emotion of fear must have arisen, and it is probably the immediate successor of hunger in the young of most animals. Anger appears as early as the mind can appreciate resistance to its first desires, and no doubt followed as third or fourth in the history of evolution. The rudiments of parental feeling would follow the origin of reproduction at a considerable interval of

time. One of the latest of the instincts to appear would be the love of power; while later still would be the emotions of relativity (Bain), because they are dependent on a degree of mental appreciation of objects. Such are admiration, surprise, and wonder. These, as well as all other consequences of inherited intellect, appear earlier in infancy than they did in evolution, by the process of "acceleration," as may be readily understood.

Of these instincts and emotions it is to be supposed that hunger remains much as it has ever been. The reproductive instinct has, on the other hand, undergone the greatest modifications. Sex instinct could not have existed prior to the origin of the differentiation of sex. Hence it is probable that the parental instinct preceded the sexual in time. These two instincts, being the only ones which involve interest in individuals other than self, furnish the sources of sympathy in all its benevolent aspects. Hence it has developed in man into the powerful passion of love; into affection and charity in all their degrees and bearings. Fear being, as Bain shows, largely dependent on weakness, has varied in development in all times, but must be most pronounced in animals of high sensibility, other things being equal. Hence its power has, on the whole, increased until it probably reached its extreme in the monkeys or the lowest races of men. Increasing intelligence of the higher order diminishes the number of its occasions, so that it is the privilege of the highest type of men to possess but little of it. The earliest of the emotions of relativity to appear in time has probably been the love of beauty; how early it may have appeared it is difficult to imagine. Surprise and wonder, as distinct from fear, one can only conceive as following an advanced state of intelligence.

Thus in psychology the paleontological order of development is somewhat different from the embryological. I have compared the two orders as follows: *

PALEONTOLOGICAL.	EMBRYOLOGICAL.
Hunger.	Hunger.
Reproduction.	Fear.
Fear.	Anger.

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Anger.	Beauty.
Parental instinct.	Wonder.
Sex.	Power.
Power.	Pity.
Beauty.	Sex.
Wonder.	Parental instinct.

The qualities enumerated in the first column follow each other directly in order from the simple to the complex. In the second column this order is disturbed by the earlier appearance of the derivative emotions, beauty, wonder, and pity or benevolence, and the later appearance of the simple emotion of sex. Thus in psychological as in other evolution some of the products of development appear earlier and earlier in life in accordance with the law of *acceleration*.

It is evident that a capacity for ideation has been developed, which is capable of conception or generalization. This is seen in the capacity which animals frequently display of adapting themselves to new situations. This is accomplished by the conception of the general resemblance of the new case to certain old ones, although there may be much difference in detail. Thus Mr. Belt tells of an army of ants on the march which crossed a railroad track on which cars were frequently passing. The wheels crushed the ants as they crossed the rails. This was observed by the ants, who at last escaped the danger by burrowing under the rails. Mr. Beaumont relates that some Termites which he had imprisoned in a glass jar with perpendicular sides escaped from it by an ingenious use of a secretion of their bodies which they ordinarily used in building their nests and covered roadways. The soldiers furnished the workers with a semifluid cementfrom their bodies, which the latter deposited on the glass, where it hardened. They thus made a roadway to the top of vessel, over which the insects passed out. The faculty has plainly developed from the simple to the more complex. The difference between the dart-throwing of the Infusorian Dinidium and the dam-building of the beaver is one of degree only, and not of kind. The difference of degree resides in the more numerous means necessary to the beaver's act than to that of the Dinidium.

The latter throws only its own indurated cilia; the beaver uses the earth for burrowing, the water for covering, and the timber for building both the dam and its house. The more complex the performance the more likely is the animal to employ also the deductive act. Thus in the case of the building of nests by birds and trap-door spiders, when customary materials are wanting, new ones are adopted; that is, a known rule as applied to new cases.

The manner of the evolution of the concept has been as follows: The sensible qualities of objects are first learned, and stored in the memory. The qualities must be distinctly localized in the nervous centers, otherwise confusion of memory would result. Thus if a red bird is perceived to sing on a tree four distinct perceptions are experienced. First, a bird's form; second, a red color; third, the song of a bird; fourth, a particular tree on which the bird was perched. It is not probable that that part of the nervous center which perceives form is identical with that which perceives color, nor either with that which perceives sound. The constituent parts of the center have become specialized into different regions, each capable of apprehending a different quality. Each locality is blind or deaf, as the case may be, to that stimulus which affects the other, although all may be alike reached by the vibrations, or whatever the form of stimulus may be, which is derived from the common source. And each is so joined by connecting nervous threads with all of the other localities, that the general idea of the entire object is not lost. Thus we may believe that there is a localization of the sense of form, where forms are recorded, and may be compared and their identity or difference be consciously known. In simple minds identity would be often perceived, and slight differences be disregarded. Hence the simple conceptions of the animal mind. In more advanced minds, with greater specialization and organization of structure, minuter differences, as well as wider resemblances would be recorded, and would enter into consciousness. The combination of percepts form the lowest grade of concepts. Still higher development would render possible wider combinations through the development of nervous connections between more

widely separated localities of record, and their conduction to added portions of the center or locality of gray tissue, where consciousness would necessarily perceive the resemblances and differences thus set before it.

Finally, the lower concepts thus gathered from perceptions could be transmitted to a functionally still higher center, where their resemblances and differences should become obvious to consciousness, and the highest concepts, inductions, or judgments result.

In the tracing of the development of this mechanism and its function, I once more call attention to the fact that without the presence of consciousness the whole process is useless as a mental evolution. I must consider later the question as to how or why the specialization or location of sense-perception should take place. That it actually exists has been demonstrated by the researches into brain and cordal physiology conducted in recent years.

Leaving for a moment the question of the physical basis, I revert to the metaphysical side of evolution of mind. It is generally admitted by evolutionists in the field of psychology that experience is the immediate agent of such evolution; or, in other words, that it is a process of education, the possibility of such education being dependent on consciousness and memory. There is here no ambiguity as to the method. Consciousness is educated by the direct action of the environment as determined by the active or passive condition of the organism. In other words, the environment impresses itself directly on the consciousness of the organism, and a memory remains, which is the guide to the future movements of the latter, and this process has been in operation ever since life has existed, and the result has been the human mind.

We have here no promiscuous or fortuitous activity of sensation, nor is any possible, since sensations are only produced by a stimulus from a definite material source. There is no "survival of the fittest" at this stage of the process, but a calling into being of new sensations, and consequently of new movements. Here we have the origin of mental changes distinctly before us, and the question of their survival comes up at

a later stage of evolution. Responses to stimuli are, however, necessarily "fit" or appropriate to the stimulus, and it can only be other features in the environment which can make them otherwise. And this unfitness cannot continue,—not because its possessor is necessarily destroyed, but because new environments produce new sensations and new educations. It is therefore in the evolution of mind that the doctrine of natural selection breaks down completely, even as a directive agent. As an originative method it has no application.

We have now reached the keystone of the arch of evolution, so to speak, and we can retrace our steps over the ground of the origin of structure, with which we commenced. The next question which we have to discuss is that of the effect of mental conditions on the movements of organisms.

THREE CASES OF HYPOSPADIAS IN WHICH THE SEX WAS UNDETERMINABLE UNTIL PUBERTY.

BY DRS. L. H. AND W. H. LUCE.

THESE cases are chiefly interesting from the fact that they all occurred in one family; and on account of the slow evolution of the organs continuing after birth up to puberty.

The cases, the subject of this article, consisted of three of six children. The parents were of normal development physically, but of strong nervous temperaments, there being cases of insanity on both sides,—the father on the paternal side, and nieces on the maternal side. The father was a sea captain (whaling), intelligent, of indomitable courage and great energy. The mother was also intelligent, and above the average in courage and energy, belonging to a large family of sturdy sea captains celebrated for their hardihood. The two did not live happily together; the wife, it was said, was frequently the subject of maltreatment at the hands of her husband *during her pregnancies*. There were no cases of deformity or deaf mutes in any of the ancestry on either side,